# PATENT SPECIFICATION

**888,847**

DRAWINGS ATTACHED.

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## COMPLETE SPECIFICATION.

## A Directly Heated Cathode Wire.

We, TESLA, NARODNI PODNIK, of 186 Podebradska, Prague IX, Czechoslovakia, a Czechoslovak National Corporation, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

This invention relates to a cathode wire for directly heated cathodes, more particularly for high power transmitting valves.

Such cathodes consist of a certain number or wires arranged in series or in parallel, the temperature of these wires not being the same at all places. Due to this fact, the resulting characteristic is not the sum of identical partial characteristics of the various cathode sections, but the sum of different characteristics.

The saturation current of an emitter rises with its temperature. The electron current emitted by cathode wire sections having a lower surface temperature becomes saturated at a lower positive voltage of the other electrodes than the current emitted from the sections of the cathode wire with a higher surface temperature. The sum of these different saturated partial currents yields a characteristic which causes non-linear distortion of the amplified currents and voltages.

The dimensions of such valves operating in the short wave region should be as small as possible. Therefore, as much as possible of the entire cathode surface should be employed for producing cathode current.

The cathode temperature is affected, on the one hand, by heat radiation of adjacent cathode wires and, on the other hand, by abrupt differences in the cross-sections of the wire and support which cause higher heat condution at the lead-in and at the opposite and where all cathode wires are joined together. Also here, the balance between the supplied and the radiated and dissipated heat is disturbed. The conduction effect of the supports or links at each end of the cathode wire reaches far into the active zone of the cathode wire.

The effect of the non-uniform temperature distribution can be limited by improving the balance between the supplied and dissipated heat. To this end the radiating wire surface may be artificially reduced and the heat produced by the ohmic resistance of the wire may be increased. This object may be obtained by gradually changing the wire diameter in such a manner that it is largest in the central portion of the cathode wire where the heat dissipation is lowest, and that it becomes smaller towards both ends where the heat dissipation is higher. In this manner the surface of the wire is also reduced and its electrical resistance is increased. Creating a sufficient amount of heat at places where heat losses occur increases sufficiently the useful surface of the cathode, and a more uniform characteristic is obtained with better employment of the given length of the cathode system.

According to the invention we provide a directly heated cathode consisting of a wire assembly of pure or thoriated tungsten having a larger cross-section in the middle portion than at the ends, wherein the wire diameter is gradually reduced from the middle portion towards both ends of the wire, the length of each gradually reduced portion of the wire being shorter than the length at each end of the cathode from the position where it leaves its support or link towards the middle of the cathode, over which length there is heat conduction due to a support or a link.

The necessary size of the cathode diameter at various points of its length may be calculated with sufficient accuracy. However,

*[Price 4s. 6d.]*

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the calculated values must be corrected with regard to the necessary heating of the cathode in air during forming thereof, and also because the processes by means of which a gradual reduction of the diameter may be most readily obtained, cannot be controlled with sufficient accuracy throughout the entire length of the wire. The correct profile throughout the entire length may be obtained for example by grinding, or by means of electrolytic anodic etching.

Some types of heat treatment of the cathode affect the cross-section of the cathode wire and the roughness to its surface, which both affect the thermal balance in the various parts of the cathode wires. These changes have to be taken into account when determining the necessary reduction of the cross-section in accordance with our invention. This is done by individual adjustment.

This method is very convenient in the case of thoriated tungsten where $W_2C$ is formed by carbidization. However, this is very difficult at the cold ends of the wire. These ends suffer not only from low temperature, but also from unstable thermionic emission.

The accompanying drawing explains the invention by means of one example of embodiment. Here, the original diameter of the central portion 1 between points 2, which portion is for example 0.6 mm., is gradually reduced to 0.55 mm. towards both ends of the wire at the points 3 and 4. This reduction may be obtained for example by withdrawing the wire from the electrolytic bath at a rate determined by the desired reduction, or by controlling the etching rate. The length of each gradually reduced portion of the wire is arranged so that it is shorter than the length of each end of the cathode from the position where it leaves its support or link towards the middle of the cathode, over which length there is heat conduction due to a support or a link, the length and degree of taper being selected so that over the ends having the gradually reduced diameter there is no point having a higher temperature than the middle portion of the cathode.

The length of each end of the cathode where there is a cooling effect due to a support or link can be expressed numerically as a multiple of the original diameter before reduction thereof has been effected. It can be shown from known thermal theory with regard to the required mechanical strength of the cathode wire that this length is 12 to 25 times the original diameter of the cathode.

WHAT WE CLAIM IS :—

1. A directly heated cathode consisting of a wire assembly of pure or thoriated tungsten having a larger cross-section in the middle portion than at the ends, wherein the wire diameter is gradually reduced from the middle portion towards both ends of the wire, the length of each gradually reduced portion of the wire being shorter than the length at each end of the cathode from the position where it leaves its support or link towards the middle of the cathode, over which length there is heat conduction due to a support or a link.

2. A directly heated cathode as claimed in Claim 1, wherein the reduction of the wire diameter towards the two ends of the wire is kept within such limits that the surface temperature of the wire at these places does not exceed the temperature of the central active portion of this wire.

3. A directly heated cathode substantially as described with reference to the accompanying drawing.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale.*